



Staff Update on Liquefied Natural Gas

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Overview

- **State energy policy**
- **LNG and its properties**
- **Safety and environmental issues**



Why the interest lately in liquefied natural gas?

- The U.S. is relying more on natural gas for cleaner power generation.
- Canadian and Lower 48 states' gas production is declining.
- LNG links U.S. consumers to transoceanic gas supplies from many countries.
- LNG delivery costs have declined.



California's Energy Policies

- ***Energy Action Plan***

- Evaluate new supply options, such as LNG imports

- ***Integrated Energy Policy Report***

- Encourage LNG facilities in California or Baja California, Mexico
- Ensure new facilities protect the environment and public safety
- Coordinate permit reviews and address local concerns



What is LNG?





LNG is natural gas in liquid form.

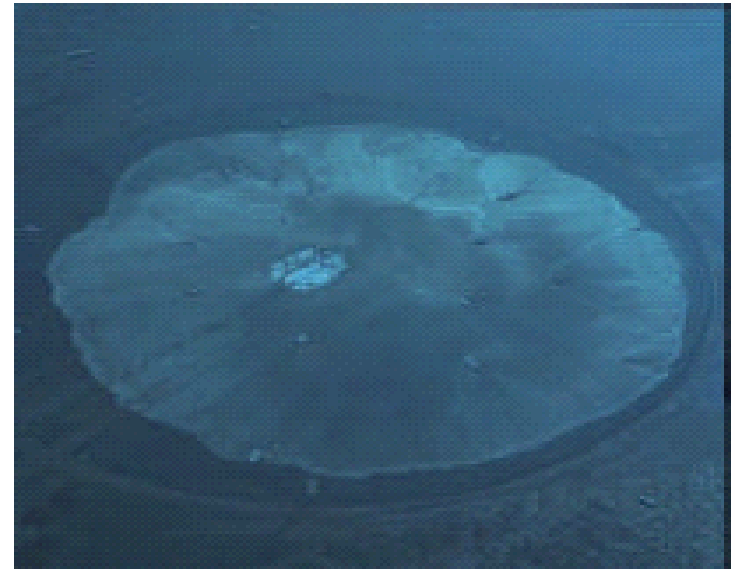
- **Primarily methane**
- **Cryogenic liquid (-260°F)**
- **1/600th volume of natural gas**
- **Non-toxic and non-corrosive**
- **Colorless and odorless**
- **Can not ignite**
- **Contact is hazardous due to extremely cold temperature.**





As a liquid, LNG:

- Is stored as a liquid in well-insulated tanks at near-atmospheric pressure
- Floats on water, then vaporizes
- Large spills on water may produce a rapid phase transition (non-combustion explosion)





LNG Vapor Cloud Characteristics

- Looks like fog
- Lighter than air once above -160°F
- Leaves no residue on land or water





LNG Vapor Cloud Characteristics, continued



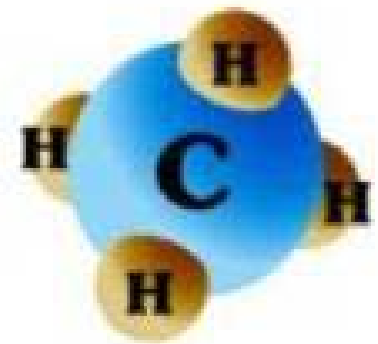
- Highly flammable within cloud, where gas volume is between 5% and 15%
- Cloud remains flammable until gas volume $<5\%$.
- Not explosive, unless ignited in an enclosed space



How is LNG Used?

- **As natural gas:**

For heating, cooking, electricity generation, industrial feedstock (e.g., making fertilizer, chemicals)

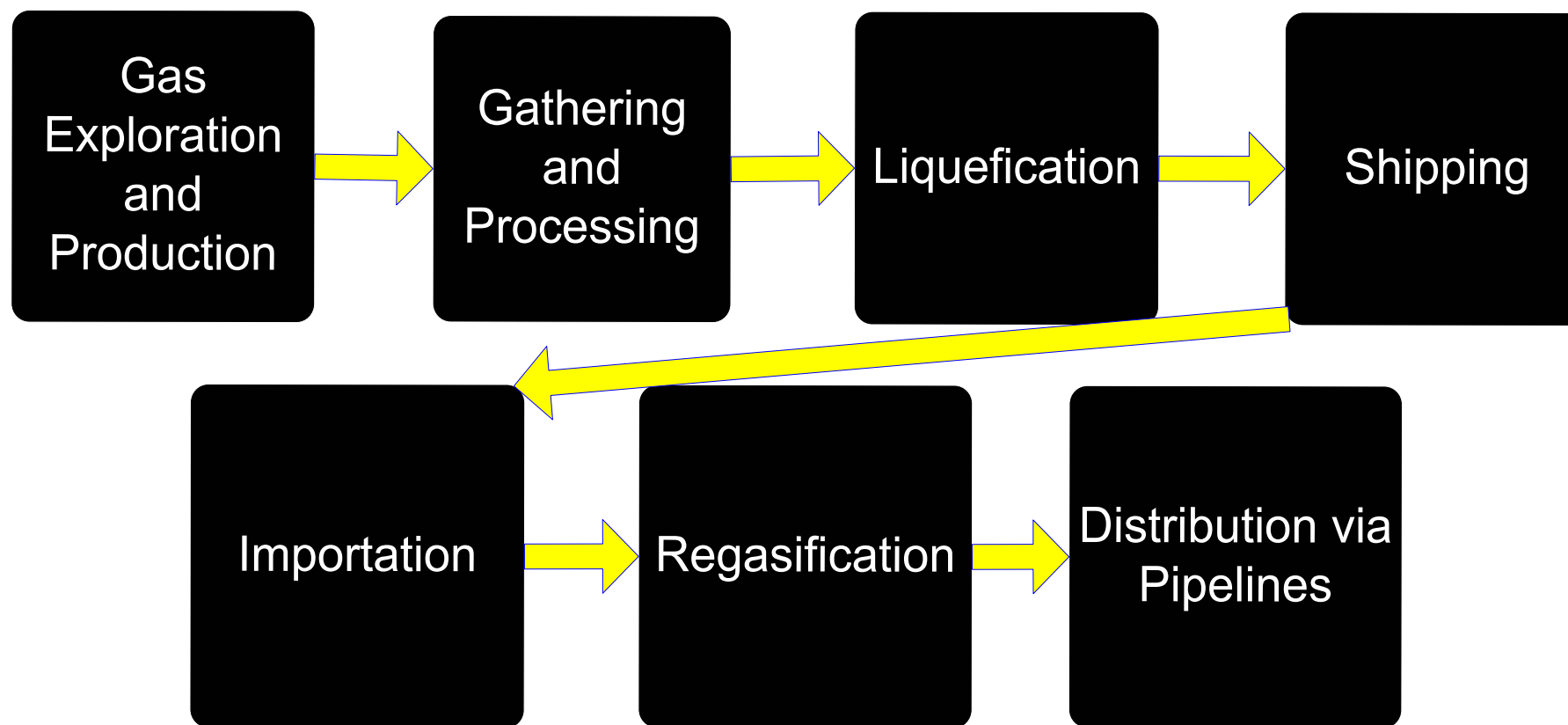


- **As LNG:**

For vehicle fuel, storage supplement to gas utility's inventories



The LNG “Supply Chain”





The LNG Industry

- **Approximately 30 years old**
- **Atlantic Basin buyers:**
 - **Belgium, France, Greece, Italy, Portugal, Spain, Turkey, and the United States**
- **Pacific Rim buyers:**
 - **Japan, South Korea, and Taiwan**
- **More than 40 receiving terminals worldwide**



Worldwide LNG Facilities



- - Existing LNG Import Terminals
- - Planned Import Terminals
- - Existing LNG Export Terminals
- - Planned Export Terminals

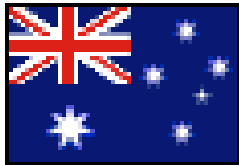
Source: *CH-IV International*



Current LNG Producers



Algeria



Australia



Brunei



Indonesia

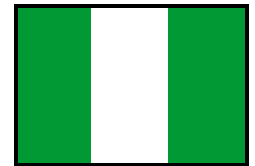


Libya

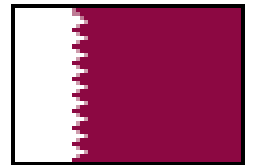


Malaysia

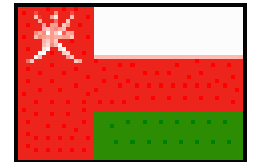
Nigeria



Qatar



Oman



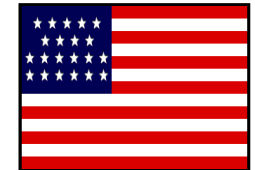
Trinidad



United Arab Emirates

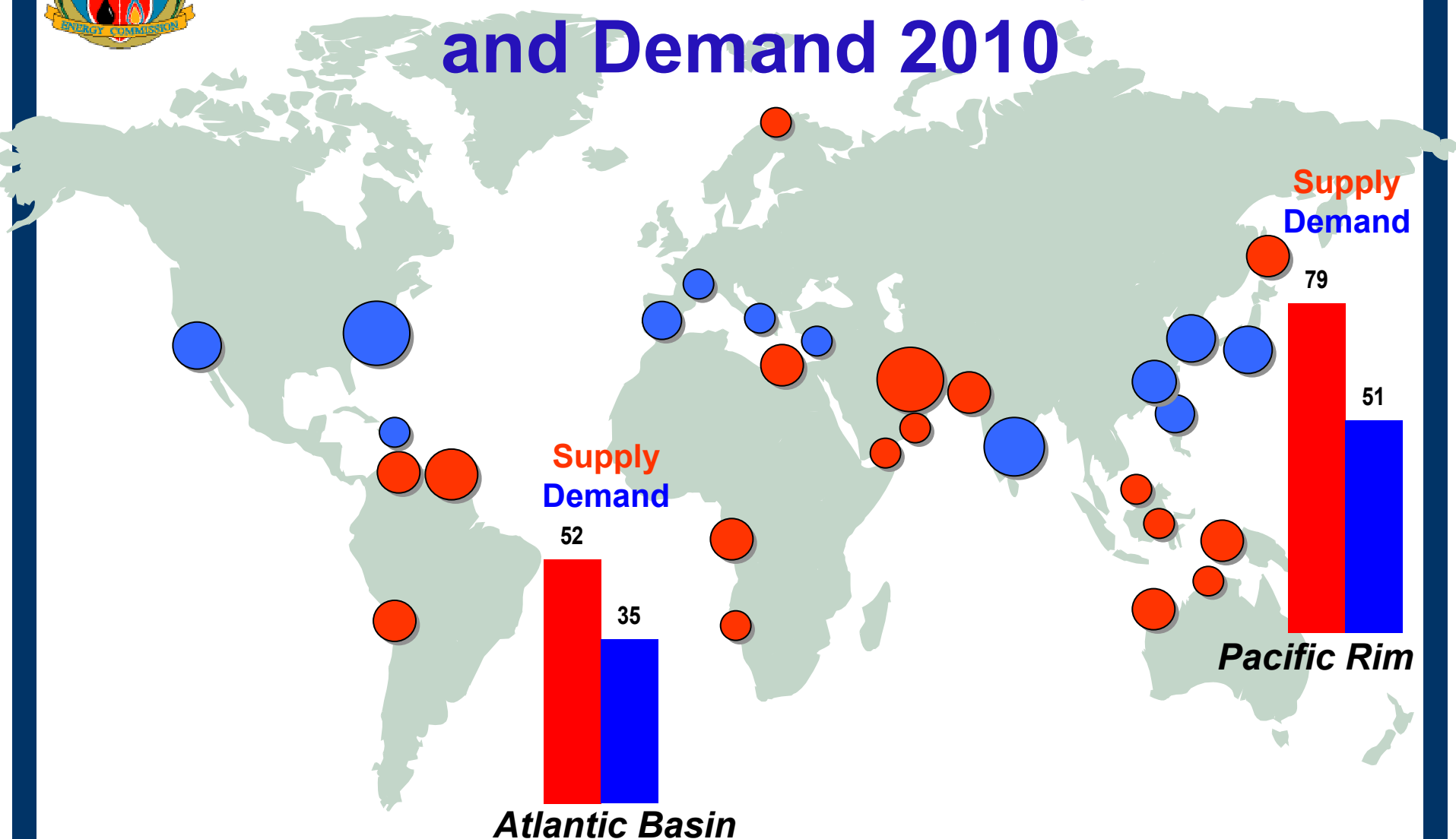


United States



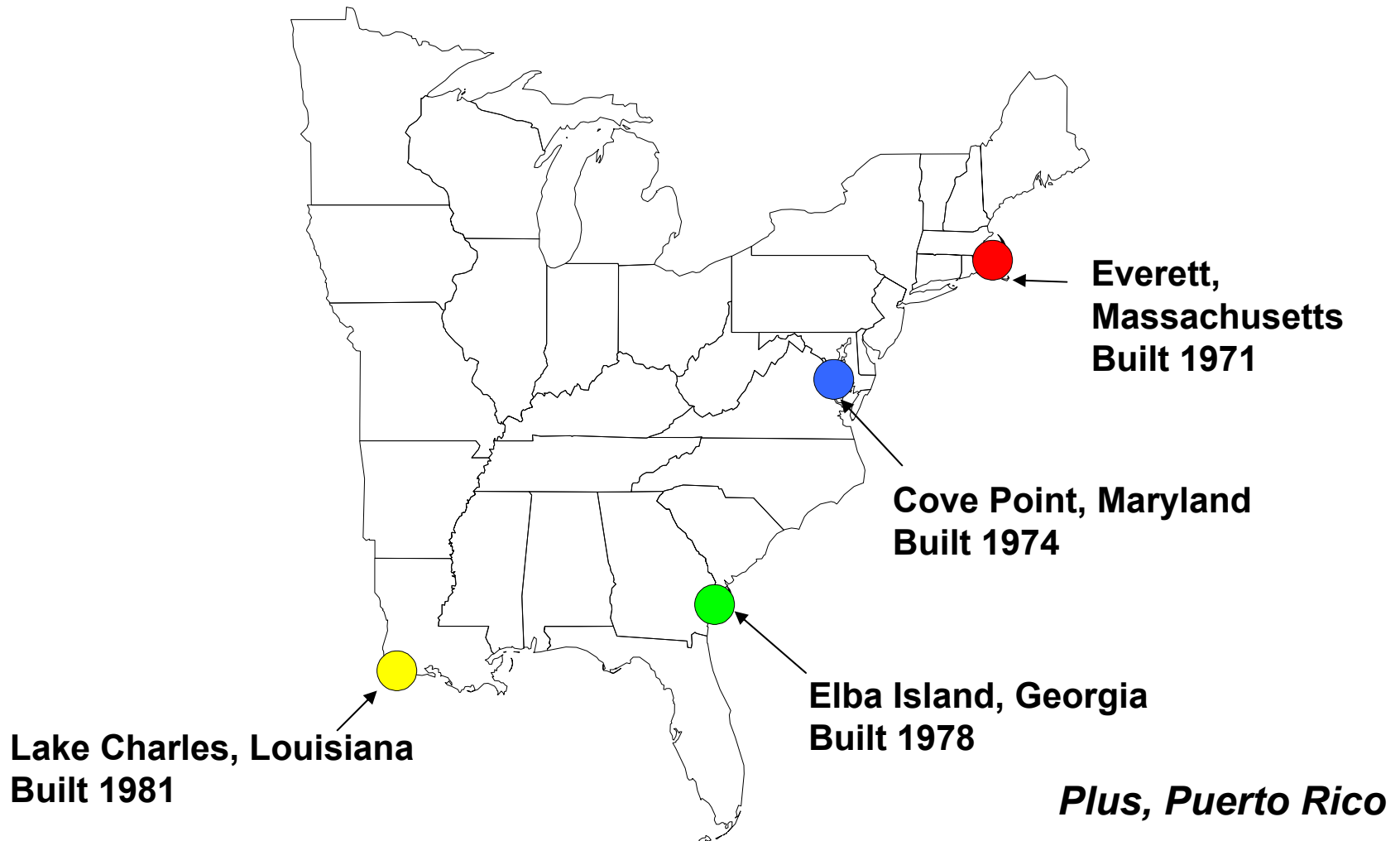


LNG Potential Supply and Demand 2010





U.S. LNG Import Facilities





All U.S. import facilities are adding capacity.

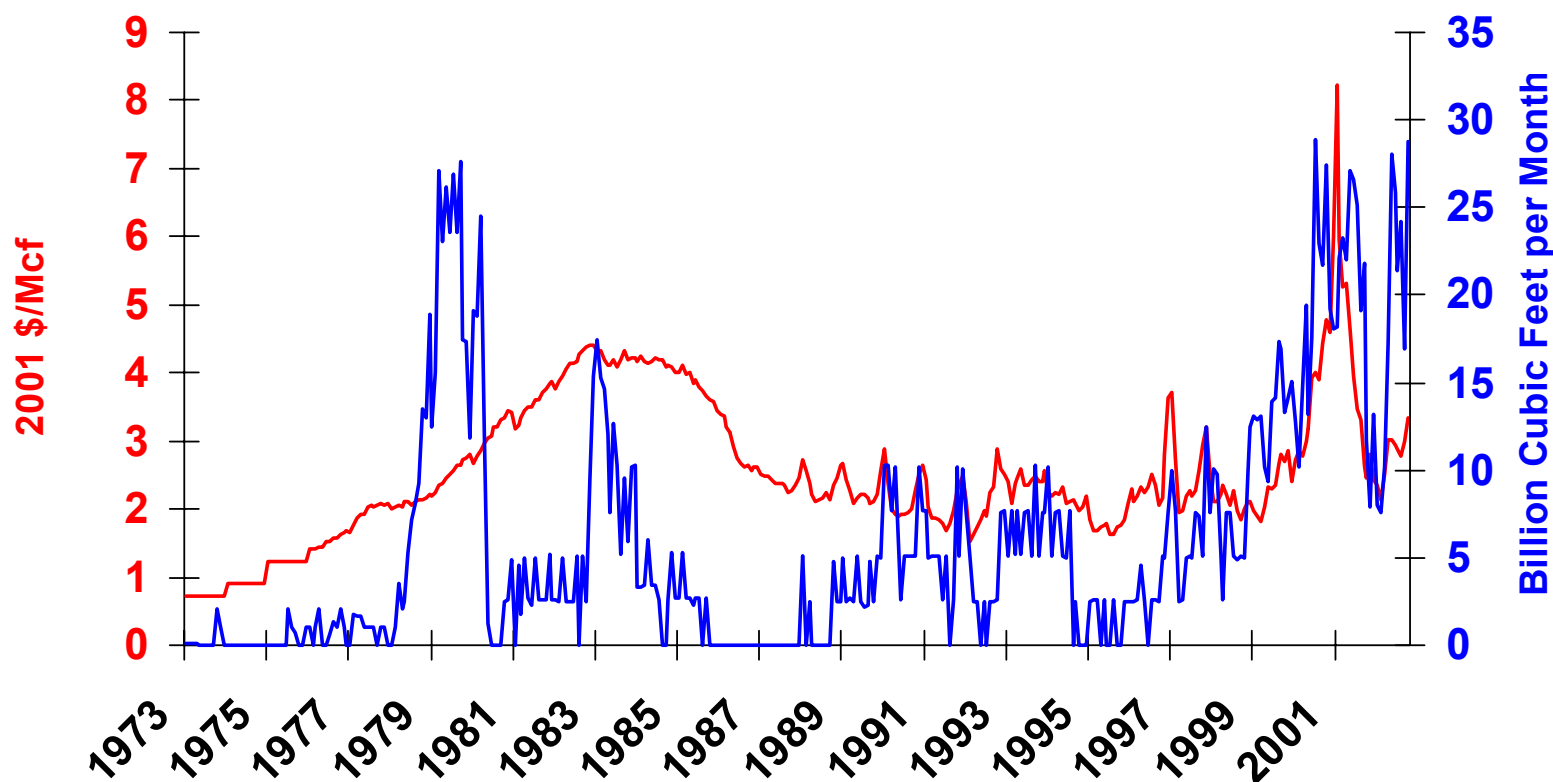
	<u>Now</u>	<u>Future</u>
• Everett, Massachusetts	435 MMcf/d	▶ 700 MMcf/d
• Cove Point, Maryland	430 MMcf/d	▶ 1 Bcf/d
• Elba Island, Georgia	600 MMcf/d	▶ 1.2 Bcf/d
• Lake Charles, Louisiana	750 MMcf/d	▶ 1 Bcf/d

Total	2,215 MMcf/d ▶ 3.9 Bcf/d
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(MMcf/d = million cubic feet per day; Bcf/d = billion cubic feet per day)



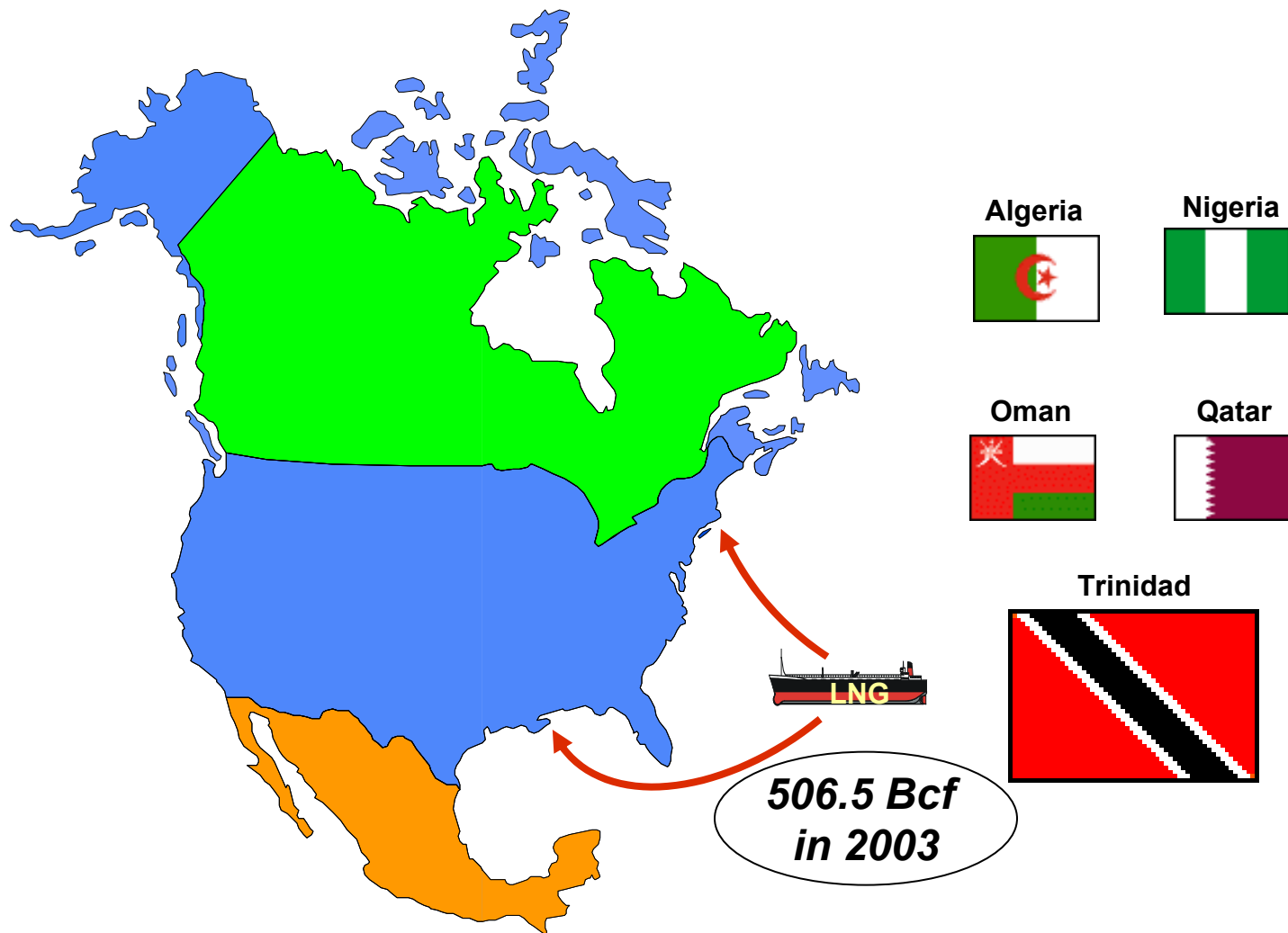
Trends in LNG Imports – relative to natural gas prices



SOURCE: *U.S. Energy Information Administration*



Current U.S. Sources of LNG





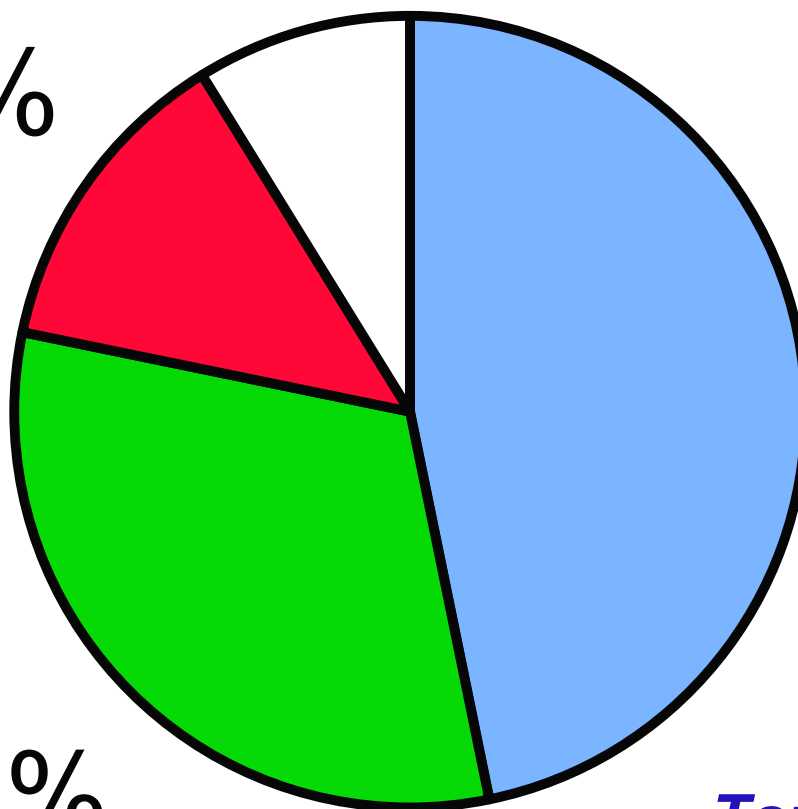
LNG Deliveries in 2003

Elba Island, Georgia 9%
44 Bcf

13%
Cove Point,
Maryland
66.1 Bcf

Everett,
Massachusetts
158.2 Bcf
31%

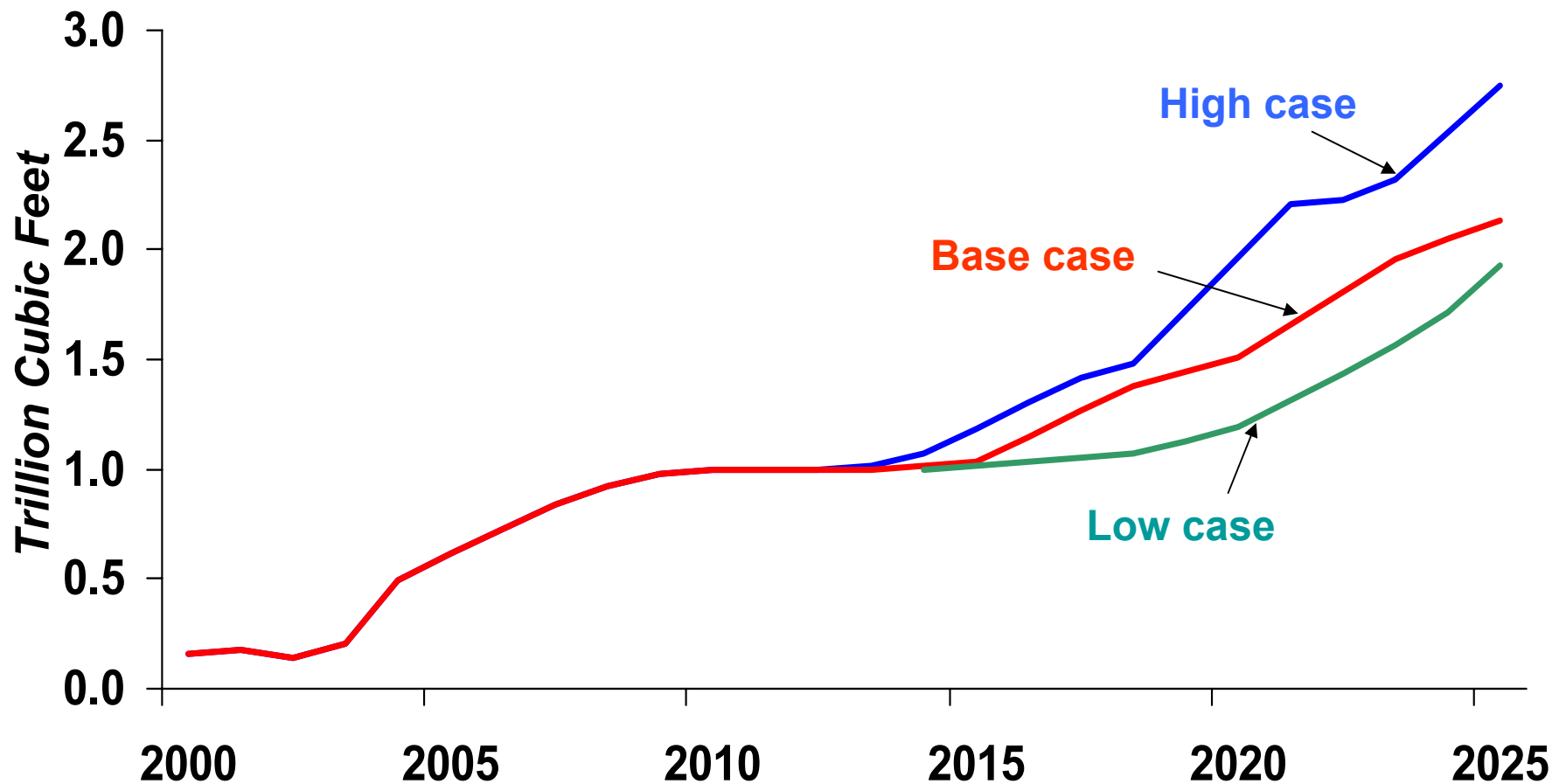
Lake Charles,
Louisiana
238.2 Bcf
47%



*Total – 506.5 Bcf,
excluding Puerto Rico*



Projected Net LNG Imports 2000-2025



SOURCE: *U.S. Energy Information Administration*



Potential LNG Sources for the West Coast

Source Country	Distance (One-way, @ 18.5 knot ship speed)
Oman	25 days
Australia	18 days
Malaysia	17 days
Indonesia	16 days
Brunei	16 days
Russia	11 days
Alaska	5 days



Transporting LNG





LNG is transported in specially designed ships.

- Most carriers are 900 feet long, 140 feet wide, 40 feet high
- Carry \approx 35 million gallons of LNG, 3 Bcf





LNG Carriers

- Double-hulled and well-insulated (not refrigerated)
- Store LNG at near-atmospheric pressure (not pressurized)
- Use “boil off” gas as on-board fuel
- Many safety features for cargo containment and fire prevention





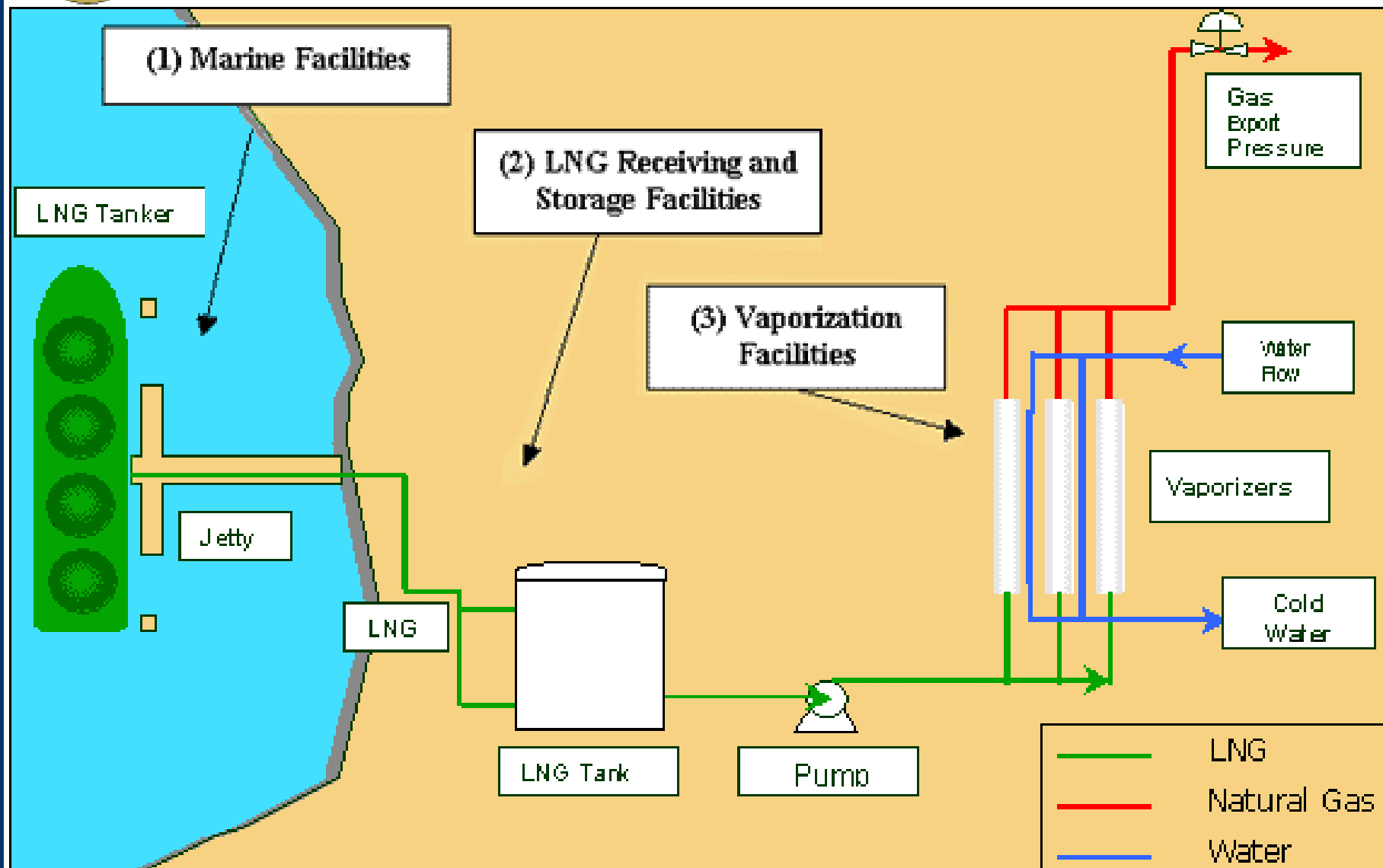
LNG Terminal Components

- Berth and jetty
- Unloading arms
- Storage tanks
- Vaporizers
- Control room
- Connection to utility-pipe network





LNG Facility Layout





LNG Facility Site Choices

Onshore

- Existing port
- Remote coastline





LNG Facility Site Choices

Offshore



Technology Options:

- Attached to platform
- Attached to pipeline with vaporization on carrier
- Artificial island
- Floating, moored to seabed



LNG Terminal Siting

“Best Practices”

- Adequate acreage for safety exclusion zones
- Compatibility with other maritime traffic





LNG Terminal Siting “Best Practices” (cont.)

- **Access to pipeline infrastructure**
- **Local community acceptance**
- **Consistent with current land-use zoning**
- **Coordinated federal, state, and local environmental approvals**
- **Use of latest storage and transfer-system technologies**



LNG Safety Concerns

- **A fire from a large release of LNG will burn intensely. Little smoke.**
 - Potential harm to plant employees
 - Potential damage to LNG marine terminal and offsite facilities
 - Large fires must burn themselves out.
- **LNG firefighting is like fighting any hydrocarbon fire.**
 - Firefighters attend hands-on training.
 - Fire detection sensors trigger alarm and shutdown.
 - Special dry chemicals, expansion foam control small fires, not water.





LNG facilities must have buffer zones for public safety

- ***Thermal exclusion zones*** are designed to prevent public exposure to thermal radiation from a fire.
- ***Vapor dispersion zones*** are designed to prevent public exposure to unlit vapor clouds that could ignite later.
- ***Security zones*** are designated to prevent ship collisions with LNG carriers.



LNG Carrier Safety Record

- No LNG cargo spills due to ship collisions, groundings, fires, explosions, or hull failures
- No damage to land-based property or the environment due to LNG releases from carriers
- No fatalities

SOURCE: *Lloyd's Register*



Two Fatal Accidents at LNG Plants

- **1944 - Cleveland, Ohio (peak-shaving plant)**
Storage tank failed. LNG spilled into the sewer.
Underground explosion killed 128 people.
- **1979 - Cove Point, Maryland**
Valve leaked LNG along an electrical conduit
and into an equipment room. Explosion killed
a plant employee.



Safety Risk Assessments

Postulated “Worst Case” Scenario (example)

- **Carrier collides with another ship, rapid release of a large amount of LNG**
- **Spill spreads on water. Vapor cloud forms.**
- **Cloud drifts to urban area, then ignites.**
- **Fire kills people, destroys property.**



Safety Risk Assessments

- Reasonable assumptions for “worst case” scenario:
 - Where could a carrier-damaging collision occur?
 - What is the spill rate? Would spill be instantaneous?
 - Will the *collision* start a fire? Or, is ignition delayed?
- Site-specific data on facility layout & design, topography, waves, humidity, wind speed, etc.



Safety Risk Assessments

Dense cloud dispersion models predict:

- thermal radiation heat flux**
- distance traveled while still flammable**

**Using the same assumptions and data,
all such models predict similar results.**



Quest Model Controversy

- **Performed shortly after 9-11 for U.S. DOE**
- **Assumed:**
 - **Collision occurred outside of Boston Harbor**
 - **Rapid, but not instantaneous, LNG release**
 - **Waves hasten LNG vaporization**
 - **No ignition until cloud is biggest size while still flammable**



Comparison of Results

Distance that a 25,000 m³ LNG spill spreads:

- **470 feet (Quest)**
- **1,411 feet (James Fay)**
- **1,239 to 1,539 (Others)**

No scenario assumed the collision starts a fire.

Other's analyses yielded bigger numbers, because:

- **Collisions occur *inside* Boston Harbor.**
- **LNG release is *instantaneous*.**

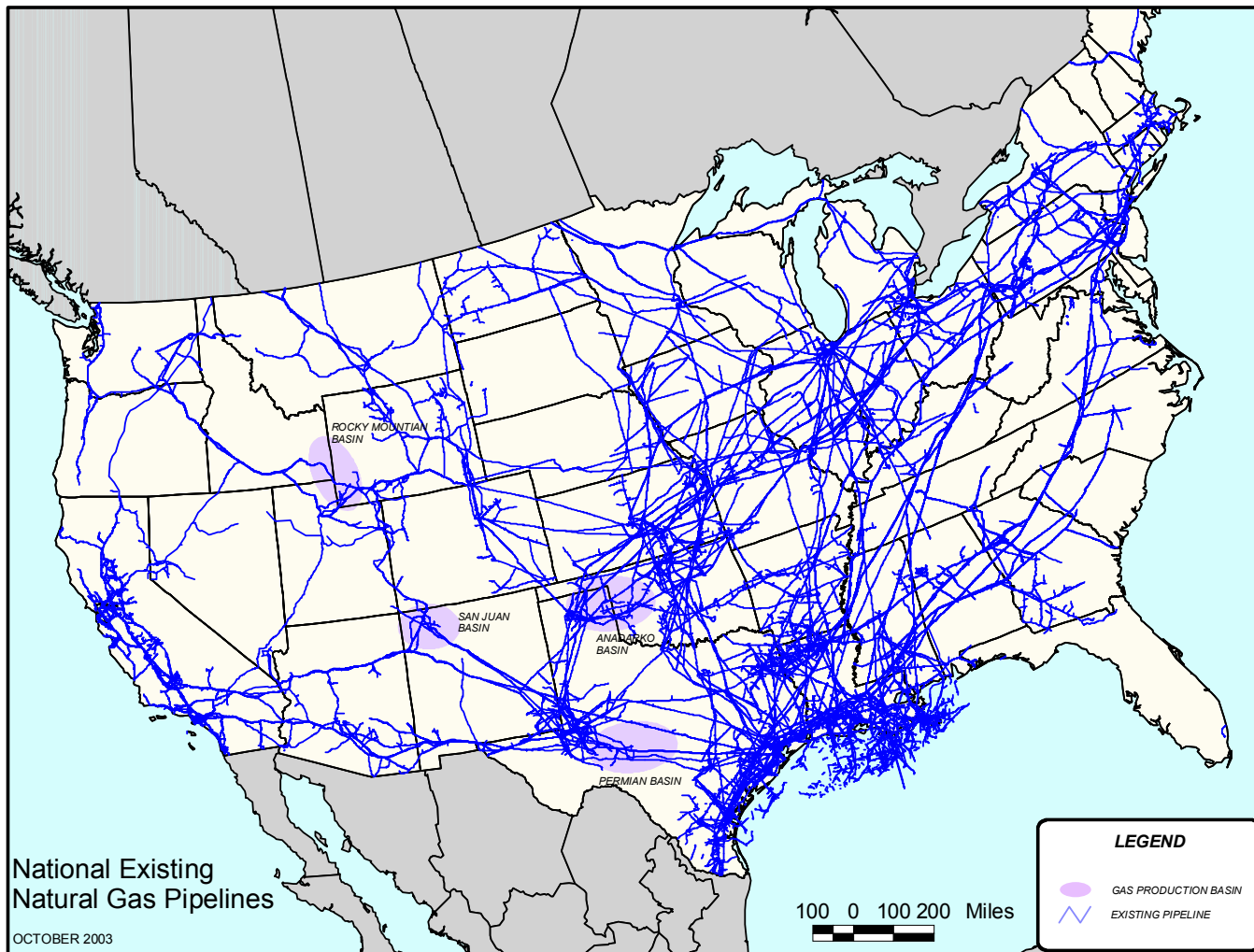


Pipeline Safety

- **Ownership of pipelines determines state or federal safety jurisdiction.**
- **Federal pipeline safety regulated by US Department of Transportation under 49 CFR 192**
- **The CPUC has adopted the federal pipeline safety regulations under General Order 112E, and enforces these regulations on operators under its jurisdiction.**



U.S Pipelines



T:\Projects\CEC\Gas Lines.D. Midwestern natural gas pipelines.apr



California Pipelines





Potential Environmental Impacts

LNG projects are subject to environmental review and regulation.

Environmental impact evaluations cover:

- **Air quality**
- **Water resources**
- **Biological resources**
- **Land use**
- **Visual impacts**
- **And more**



Potential air quality impacts from LNG facilities

Emission sources include:

- Natural gas burned for LNG vaporization
- Diesel-fuel emissions:
 - Emergency generators
 - On-ship power supply
 - Tug boat engines

LNG facilities do not routinely flare or vent natural gas, only in emergencies.





Water Resources

LNG plants do not consume large amounts of water or produce a lot of waste water.

If seawater were the heat source for vaporization, large quantities of sea water would flow through the system.

- **Cold-temperature seawater would be discharged.**
- **Marine life could be entrained.**





Biological Resources

LNG ships don't discharge ballast after arriving at an import terminal.

Ports may need to dredge and fill ship waterway.

Pipeline routes may:

- **Cross critical marine habitat, streams, or wetlands**
- **Require plant life removal, replacement**





Visual Resource Impacts

**Terminals are
industrial facilities.**



West Coast LNG Projects



Past and Proposed



Past proposals to build terminals in California

- **Point Conception (1970s)**
- **Mare Island (2002)**



Point Conception project history

- Proposed by California gas utilities
- Multiple sites considered, Point Conception selected
- Despite public opposition and lawsuits, project eventually approved
- Change in U.S. gas regulations boosted domestic supplies, hurting LNG market
- Project never built

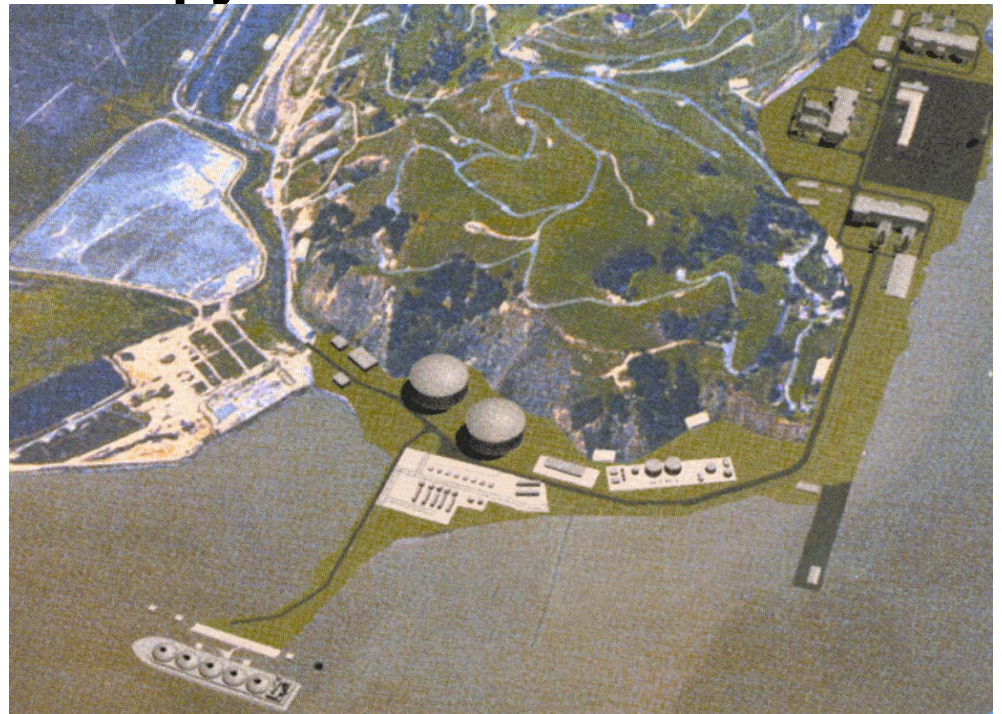


Photo Credit: Kenneth Adelman



Mare Island project history

- LNG project proposed by Bechtel & Shell in 2002
- Site was a former naval shipyard within San Francisco Bay
- Citizens opposed the project
- Shell, then Bechtel, withdrew proposal



(Artist's Rendition)



Proposed LNG projects under consideration for California

Name	Location	Status
Long Beach LNG Facility Sound Energy Solutions	Port of Long Beach	Joint EIS/EIR by FERC and Port of Long Beach.
Cabrillo Deepwater Port BHP Billiton	~12 miles off shore of Ventura County	Joint EIS/EIR by Coast Guard and State Lands Commission.
Crystal Clearwater Port Crystal Energy LLC	~11 miles off shore of Ventura County	Filed application with Coast Guard and State Lands Commission.
Samoa Point Energy Center Calpine	Humboldt Bay	Announced project.
Port Penguin ChevronTexaco	To be determined	Announced project.



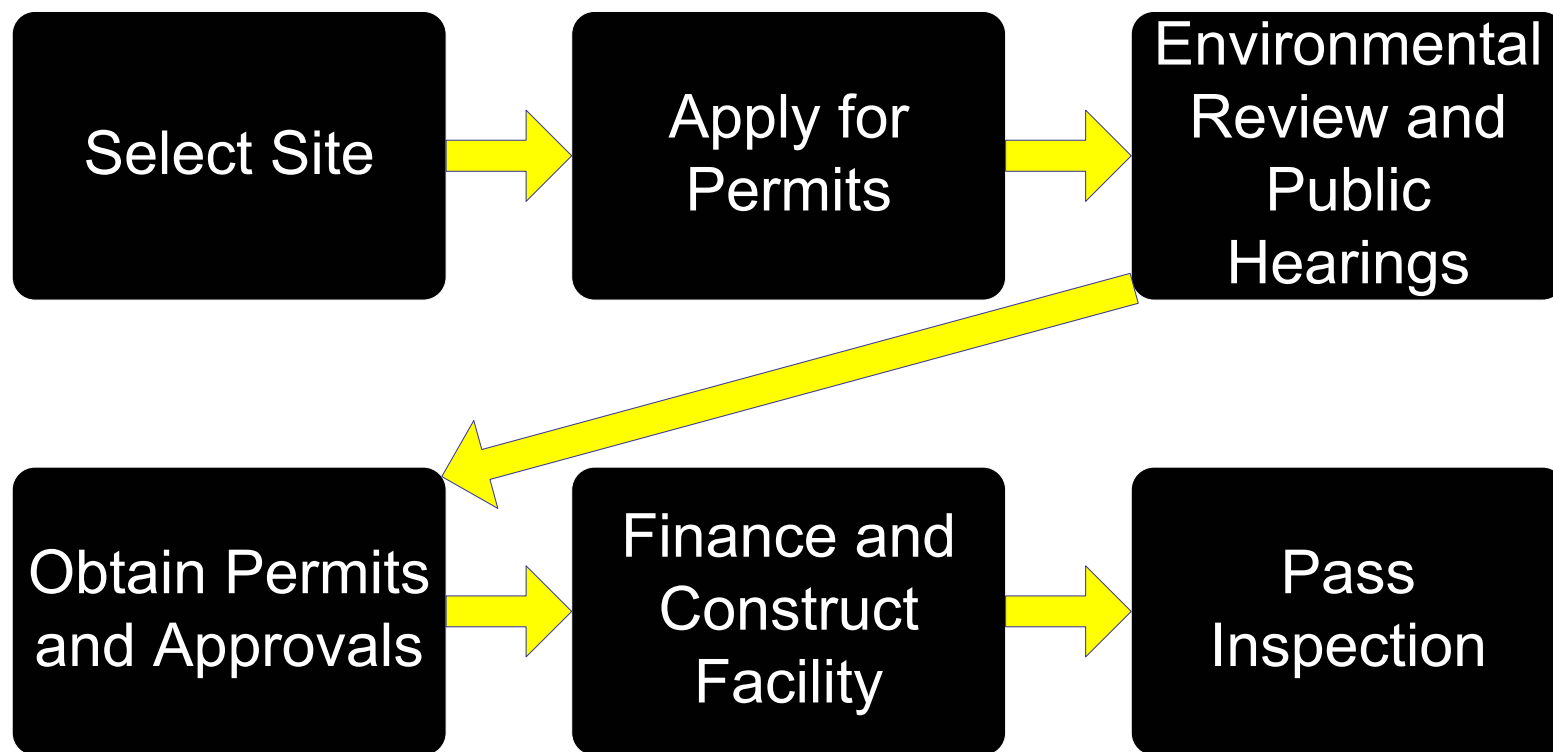
Proposed LNG projects under consideration for Baja California

Name	Location	Status
Terminal GNL Mar Adentro de Baja CA ChevronTexaco	Offshore, Tijuana	Project Announced
Tijuana Regional Energy Center Marathon	Tijuana	Obtaining permits
Energia Costa Azul Sempra and Shell	Ensenada	Permits suspended by Mexican Court



Is LNG a near-term supply source for the West Coast?

- Earliest estimate ~ 2006
- Siting process could take ~ 4 to 7 years





Federal, State and Local Authorities involved with LNG



Federal Agencies with Review or Permit Authority over California LNG Facilities

Onshore Terminals

Federal Energy Regulatory
Commission

Department of Transportation

Coast Guard

Offshore Terminals

Coast Guard

Maritime Administration

Other Key Regulators

Department of Energy

Fish and Wildlife Service and NOAA Fisheries

Minerals Management Service

Army Corps of Engineers



State Agencies with LNG Review or Permit Authority

- **State Lands Commission**
- **Department of Fish and Game**
- **Coastal Commission or San Francisco Bay Area Conservation and Development Commission**
- **California Public Utilities Commission**
- **Governor's Office (offshore terminals)**



Local Jurisdictions



- City or county government
- Port authority or harbor district

Photo Credit: Kenneth Adelman



Unresolved Issues

- **Extent of safety risks**
- **Public perception of safety risks**
- **Scope of LNG terminal regulation**
- **Price competitiveness of LNG**
- **Gas-quality standards**
- **Jones Act barrier to Alaskan imports**
- **Interstate competition for Mexican LNG**